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GUIDELINES FOR EVALUATION OF MINICOMPUTER HARDWARE AND SOFTWARE--ETC(U)
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GUIDELINES FOR EVALUATION
OF MINICOMPUTER HARDWARE AND SOFTWARE - A USER PERSPECTIVE

9 Technical Rept.

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Abstract

Guidelines are presented for the evaluation and selection of hardware and system software for minicomputers. The evaluation is presented from a non-technical user point of view as opposed to a detailed technical comparison. The issues covered include defining an approach for computing, acquiring a minicomputer system, negotiation with vendors, installation and operation. Case examples are given along with examples of failure.

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1. Introduction

Computer usage is increasing on a national level. The variety of approaches to obtain access to computers has proliferated. They include the use of mainframe computers, personal calculators/microcomputers, distributed systems, and minicomputers. Each of these has potential appeal with a slightly different audience. This report focuses attention on minicomputers and application software and development using minis. Minis in this report are business computers which can be installed in user environments. The specific purposes are to answer the following questions:

- o What guidelines are necessary for adequately evaluating and selecting minicomputers systems?
- o What are the potential costs, benefits, and risks in acquiring such systems?

This paper does not select a particular solution; it does not compare vendors or products. Rather it provides a method to aid potential users in their own evaluation. It emphasizes the selection of a minicomputer and vendor development and installation of software.

The methodology addresses the life cycle of acquisition defined by:

- o Definition of requirements - determining the user and system needs;
- o Analysis of available system solutions - selecting the general direction

and approach among various minicomputer, internal computer, and outside timesharing alternatives;

- o Vendor selection - selecting a vendor for a minicomputer alternative;
- o Contract negotiation - reaching an agreement with a vendor
- o Project plan and development - planning and monitoring vendor efforts (assumes using a turnkey or limited development approach);
- o Installation and maintenance - implementing, operating and maintaining a minicomputer system.

The time necessary to do all this depends on the project and the extent of development.

The audience for the guidelines is threefold.

- o Coordinators who provide counseling to user organizations
- o Systems groups who might find the guidelines useful in providing analysis and support for inexperienced user groups
- o Non-data processing staff who do have substantial computer exposure, experience, and knowledge.

The style and approach in the guidelines is from the view of a person who has

limited EDP knowledge. No extensive computer knowledge is assumed.

For background and to obtain further information, an appendix has been developed. The appendix presents a discussion of the minicomputer industry.

2. Defining User and System Requirements

It is important to define needs in terms of functions, performance and cost. This is similar to the way a consumer approaches the purchase of an automobile. Among these factors is often a dominant problem which must be addressed from a business point of view. For example:

- o The current system running on a computer is too expensive, too slow in response time for the business need.
- o The desired application software is not available on the computer.
- o Particular hardware or system software features are not available on the internal computer hardware.
- o There is insufficient time, money or other resources to develop the system internally.

The needs of the user organization should be specified in some detail. A list of typical user requirements is shown in Figure 1. This can be used as a checklist.

The figure contains questions which identify the application, the system users, the system environment, operations, and cost and performance. Identifying characteristics of users can pin down factors relating to terminals and terminal activity. The nature of the business application is defined in terms of current operations and procedures as well as future desired requirements. Describing

the system environment leads to determining support requirements. Ongoing staffing and support requirements are addressed on the operation of the system.

The major questions on cost and performance are asked in Figure 1. The cost question is complex since the equipment may be leased or purchased; the investment tax credit may apply; accounting policies vary on amortization and capitalization.

Once these questions have been asked, the next step is to attempt to translate these user requirements into system requirements. Although this almost always requires systems expertise it is helpful to list some system requirements that may emerge. These appear in Figure 2. If the vendor identifies the system requirements, then these are in the vendor proposal.

FIGURE 1. Checklist of User Requirements

1. The Users of the System

- What are the characteristics of users of the minicomputer system?
 - o Number of simultaneous terminal users (average, maximum number of terminals active during peak periods)
 - o Physical location of users (in a contiguous area or spread out)
 - o Maximum number of users active with each applications
 - o Level of experience/expertise of users
 - o Specific functions that must be supported by terminals
 - o Print quantity

2. The Nature of the Business Applications

- What are the business functions to be performed on the minicomputer (special and general purpose)?
 - o Information flow, files and data elements, retrieval/inquiry capability, input, output (reports, files), controls and auditing procedures of current system.
 - o Desired changes/additions/deletions for new system.
- Is there a need to support an existing application(s) on the minicomputer? If so, what are its requirements now (language used, hardware needed, etc.)?
- Are the applications likely to change much over time with respect to:
 - o Number, location of users and terminals
 - o Amount of information being input, stored, or printed
 - o Functions and features of the application
- What is the relationship between applications?
 - o Are files shared?
 - o What applications are to be operated simultaneously?
 - o What interfaces with internal data centers are required?

3. The Environment of the System

- What is the physical environment of the minicomputer?
 - o Desired location of equipment, terminals
 - o Dust/dirt conditions
 - o Air conditioning/power available (business, non-business hours)
 - o Floor space available for system/need for raised floor
 - o Storage facilities for supplies

Figure 1 (cont.)

- What security control are needed by the business applications?
 - o Physical access to minicomputer
 - o Fire, flood, earthquake protection needed
 - o Backup copies of input, computer files, output
- 4. The Operation of the System
 - How many and what kind of people are needed to operate the system?
 - Who is available to manage the minicomputer?
 - Who will maintain the system?
 - How is data to be collected?
 - How will reports be controlled and distributed?
 - Will the system need to communicate with other computers by
 - o Tape/disk/diskette transfer
 - o Communication link
- 5. The Cost and Performance
 - What is the cost ceiling?
 - What are requirements for:
 - o Accuracy, error rate (extent of editing needed, rework and correction procedures, audit controls)
 - o Response time (average and peak times for response by system to terminal input by users)
 - o Volume characteristics (average and peak load of input transactions, file access and reports)
 - o Availability (times when the system must be available for access)

FIGURE 2. System Requirements

1. Hardware

- Printers
 - o Estimated number of lines per unit time and required print speed
 - o Number of printers
- Memory size
 - o Estimated size of memory, expansion limits
 - o Constraints on speed (estimated)
- Disk, diskette, tape
 - o Type, number of devices
 - o Capacity-estimated, limits
- Terminals
 - o Number, type of terminals
 - o Intelligence features (editing, special feature key, etc.)
 - o Speed, display size (CRTs), print quality (hardcopy terminal)

2. System Software

- Operating system
 - o Support of multitasking, multiprogramming (supporting multiple users and applications concurrently)
 - o Ease of use, generation (set up, take down)
 - o Terminal communication support
- Utilities
 - o Sort, merge, search
 - o File management
 - o System monitoring/reporting
 - o Aids for program development
 - o Aids for data entry/screen mapping/inquiry
- Compilers
 - o Languages supported
 - o Compatibility with those on large computers (ANSI level supported)
 - o Debugging/test data generation aids
 - o General capabilities (reentrant code, ease of use, debugging aids, etc.)

Figure 2 (cont.)

- Data base management system
 - o File handling capabilities
 - o Report generators
- 3. Data Communications
 - Protocols supported
 - Emulation as remote job entry terminal to large computers (e.g., 2780 and 3780 emulation)
 - Terminal communications - method, overhead, ease of expansion
- 4. Application Software
(Features and functions from user requirements)
- 5. Personnel/Organization
 - Staffing support for operations
 - o Data entry, batch controls
 - o Report distribution, inquiry
 - o Systems programming
 - o Management
 - Support of development, maintenance and enhancement
 - o Management
 - o Applications programming
 - o Systems analysis
 - o Data administration
 - Support for installation
 - o Program conversion (if any)
 - o Data conversion (if any)
 - o Pilot/parallel installation
 - o Cabling/wiring/building modifications
 - o Training
 - o Forms design
 - o Documentation

3. Analysis of Available System Solutions

o Possible Solutions

At this point effort has been expended to develop requirements for a computer based system. A general solution must now be selected for computerization. Several possibilities are:

- Developing a system internally to run on an internal computer center;
- Acquiring a software package to run on an internal computer center
- Using an outside timesharing vendor or service bureau (the vendor supplies a timesharing computer; users access the computer via terminals);
- Acquiring the minicomputer and software from a turnkey vendor;
- Acquiring a minicomputer and doing development internally.

These are not all mutually exclusive or inclusive. As an example, if one acquired a software package and had it modified, then the project might be treated as development.

In comparing the approaches to computerization generalization is risky. The viable alternatives depend on characteristics of the application system

as well as possible constraints such as management policy dictating an approach, a tight time schedule prohibiting development, lack of available resources on an internal computer center, etc.

A general comparison of the alternatives - internal development, acquiring a software package, using outside timesharing or a service bureau, and using a turnkey minicomputer approach - must take into account:

- costs (development, installation, operation)
- schedule to develop
- ease of use
- future increases in power needed
- capability to isolate functions
- need for local contact
- vendor viability
- ease of maintenance
- legal negotiation needed
- operational responsibilities
- documentation available

Figure 3 contains some common advantages and disadvantages of the alternatives. It is important to remember that these are general and may not apply in all cases.

**FIGURE 3. Some Frequently Encountered Advantages/Disadvantages
of Computer Alternatives**

<u>Alternative</u>	<u>Advantages</u>	<u>Disadvantages</u>
Internal development (minicomputer or mainframe)	Customized solution, no legal negotiation, better development control, staff gains experience, moderate operation cost	Longer development time, potential risk of failure, higher cost of development only estimated costs available, costs incurred even if failure
Software package on internal com- puter center	Low development acquisi- tion cost, tested and demonstrated software, documentation available	May not meet all user needs, legal negotiation, dependence on external organization (lack of control)
Outside timesharing and service bureaus using packages or doing development	Ease of use, communication network, software tools, specialized data bases, potentially excellent service level by vendor who is marketing oriented	High operational unit cost, less control, lack of flexibility in moving software, dependence on external organization (lack of control)
Turnkey minicomputer	Faster development time, organization is provided structure around applica- tion, moderate initial cost, total cost more cer- tain, potentially excel- lent service level by vendor who is marketing oriented	May not meet all user needs, dependence on external support, legal negotiation, need for operational staff, potential difficulty in integrating with other systems, dependence on external organization (lack of control), limited increased power

o Selecting an Approach

In order to make the decision on computerization information must be collected from internal groups as well as external vendors. Names and information on time-sharing vendors can be obtained through the Association of Time Sharing Users or internal staff members who have responsibility for time-sharing coordination. Turnkey and software firms can often be identified through advertisements or from minicomputer hardware vendors. Any hardware vendor should be encouraged to recommend software firms so that software needs are addressed. The number of vendors selected should be limited since the need here is to define an approach.

After collecting data the selection is made. This selection may not be based on detailed costs and schedule. Such data may not be available in detail. Rather it is often by elimination based on factors such as:

- Lack of application software packages for either minicomputers or data centers
- Large estimated operational cost from using an external service
- Limitation of hardware and communications support for a minicomputer

- Difficulties in organizing, coordinating, and managing a particular approach
- Lack of adequate security, controls or backup with a particular alternative
- Risk in being able to develop/modify a system for a particular alternative
- Lack of single responsible coordination point for hardware, software, and communications.

The remaining steps in the process assume that a minicomputer approach has been taken.

4. Evaluating and Selecting Among Proposed Solutions

o Data collection

Having selected a minicomputer approach vendors must be contacted so as to solicit formal proposals. The number of vendors solicited obviously impacts the evaluation time and effort. In a formal Request for Proposal effort government agencies are often inundated with proposals. However, it is equally undesirable to deal with one vendor without at least a survey of the marketplace. A frequently employed approach is to prescreen the vendors and to solicit responses from at most three to five vendors. If, after a survey, only one vendor can satisfy the requirements negotiating the contract can begin.

What information should be given to the vendor? The minimum should include:

- User/system requirements
- Schedule, budget restrictions
- List of information needed for evaluation

- Guidelines to make proposals uniform and complete (e.g., suggested outlines)
- Method of evaluation of proposals

For larger systems, questionnaires would be developed for vendors to complete. This could include a list of all requirements.

The list of information needed for evaluation includes the following:

- Relation between application requirements, as given in request for proposal and system capabilities
- Complete list of hardware, system software and application software
- Sample or proposed contract
- Pricing and payment terms
- List of current users who can be contacted, including some with similar requirements
- Provision for growth/expansion/contraction
- Estimated performance

- Vendor approach to maintenance and new releases
- Correlation between proposed system and user system requirements
- Statement of vendor's financial condition

Support material includes brochures and manuals which help explain the vendor's products. These may be, however, of limited value. Sales brochures may in some cases be misleading while manuals may be too technical.

o Initial Evaluation of Vendor Responses

The evaluation process described here is one where substantial effort is consumed in a thorough in-depth analysis. In some cases the scope of evaluation may be less, due to the limited nature of an application, a scarcity of qualified vendors, or other factors.

The general process consists of the following steps:

1. Perform initial evaluation and elimination of vendors thereby determining finalists.
2. Conduct in-depth analysis of finalist proposals.
3. Negotiate contract with successful vendor.

Here we address the first two steps. The third is discussed in Section 5. The objective in the initial evaluation is to eliminate vendor proposals which clearly do not meet the stated requirements. Some examples of reasons for elimination are:

- Inability to meet specified deadlines
- Lack of availability of function
- Proposal does not satisfy a sufficient number of the user requirements.
- The financial or staff viability of the vendor is questionable.
- Lack of compatibility with standards/hardware/software.

The initial evaluation does not usually involve visits to users or the vendor sites. These come later after the finalists have been determined. The basis for the initial evaluation are the proposal, available information in magazines and references such as Datapro. Additional information may be obtained by contacting vendors with specific questions. Vendors can also be encouraged to make oral presentations of their proposals. There are some reasons for avoiding this step - it takes time, it may add little information and it may increase vendor marketing pressure. In large government procurements there is an elaborate scoring process for evaluation. In minicomputer business selection this initial evaluation is often one of elimination of proposals which do not qualify.

The initial evaluation should be tentative in that later data may emerge which disqualify finalists and make previously eliminated bidders more attractive. For this reason no formal notification should be given until the selection of the winning proposal.

To assist in the evaluation, checklists of user requirements are helpful. The same applies to system requirements if they have been developed. Several people should read each proposal and evaluate it on the basis of the checklist.

It is possible that for larger minicomputer applications multiple vendors may be selected. If, for example, one wanted inventory and general accounting software, there might be three vendors involved - one for hardware, one for inventory software and one for general accounting software. In the initial evaluation the vendors must be sorted out as to what parts of the requirements they can meet. Then a combination of vendors can be constructed.

- o Identification of finalists - in-depth analysis

To reach this stage, each vendor would have to be classified as meeting the basic user requirements. If user requirements have been classified into those which are mandatory and those desirable, the finalists may satisfy all mandatory requirements, but may not meet all desirable requirements. By this point questions would have arisen on specific capabilities of each finalist. Some examples taken from a recent procurement are:

- When will the vendor support word processing?
- What are the capabilities of the file management utilities?
- What are the vendor's plans for memory expansion?
- How is the processor network coupled?
- Will the vendor support the latest version of COBOL?
- Will the machine emulate an IBM 3780 or some other RJE terminal?

For each vendor a list of questions and issues should be constructed. These are constructed from factors where vendor products characteristics are not known. Answering the questions successfully does not mean a vendor is selected. It merely means that the vendor is not rejected.

After the issues and questions have been identified, the method and forum for getting answers need to be defined. This can be a visit by the vendor, but if possible a visit to vendor facilities is preferable. This gives an opportunity to make many informal observations of the vendor's staff and facilities. Prior to a visit, the vendor representative should be briefed on the issues and data needed. Data might include financial reports, location of support offices, support staff, and expected response time for problems. The representative should then develop an agenda. This agenda should be reviewed to see if the appropriate topics are covered. Since topics can be covered from either a technical or marketing view, the position of vendor personnel should be ascertained. Who should go on the visit? The objective is resolution of questions on one visit. There should be an evaluation team of at least two - one representing the user and one representing technical support. Multiple visits can be coordinated on the same trip to reduce travel time.

During the visit the vendor will likely present an overview of his products. Some of the vendor personnel may not know of the requirements. After an initial general presentation, the remainder of the visit should address specific issues. A brief summary of the requirements should be presented to provide a base for the discussion. Notes should be taken and a trip report prepared as soon after the visit as possible.

Visits to user sites or contacts with users can also be made. These visits or contacts should identify the length of time used, overall satisfaction, any problems in support, security, and maintenance, ease of use, reliability of vendor and products, efficiency and performances, and unexpected surprises.

o Evaluation of finalists

After the visits to vendors and users, the evaluation of finalists can be done. As in the initial evaluation, several approaches can be used. Vendors can be eliminated individually, based on their visits. Alternatively, a scoring system can be employed. Criteria based on user requirements and performance can be listed. These criteria are then given relative weights. Each proposal is scored against the criteria. The scores are multiplied by the respective weights and totaled. The proposal with the highest total weight score is the preferred alternative. There are several limitations with such a quantitative approach. It assumes a certain level of commonality between alternatives beyond the criteria. However, the proposals may be very dissimilar; the machine architecture and languages may be different. Therefore, the usual approach for a limited number of alternatives is to proceed by elimination.

To highlight possible approaches to elimination, some examples from recent evaluations in other companies are helpful. In these cases, vendors were eliminated because of:

- Lack of field support for equipment in operating locations.
- Inexperience in dealing with a particular software applications area.
- Marginal financial condition (major officers under investigation by SEC).
- Too complex hardware and software subcontractor relationships (too many subcontractors creating potential managerial and technical problems).
- Too expensive and complex software (overkill of problem would have created problems in efficiency and maintenance).
- Future support of product line questionable (products bid were old and likely to be replaced soon).
- Limited capacity of available equipment (e.g., disk capacity, printing capability, processing rate, main memory).

- Configurations and software which were proposed as a result of misunderstanding requirements.
- Lack of successful installations of a similar nature.

These problems cannot be overcome by vendor promises that new product announcements are imminent. Frequently, these announcements are deferred due to market or technical conditions. In other cases, they are actually part of marketing so that with sufficient interest they will build the product. However, unless it is from a major vendor or can be seen and tested, the product should not be assumed to exist.

5. Negotiating the Contract

Internal legal groups can provide assistance in obtaining a suitable contract. However, it helps if potential users have knowledge of the issues that recur repeatedly in negotiations. This will facilitate working with the selected vendor as well as the attorneys involved. This section discusses contract terms from a user rather than a legal point of view. It does not replace the necessary legal review and assistance. The contract negotiation effort and terms must be scaled in relation to the product or service, the size of the vendor and their ability to negotiate. It should be pointed out that no contract is good if all parties cannot work reasonably well together.

What can be negotiated? Or, what terms must be settled? The obvious one is price, but even here the price can be defined in terms of licenses (fixed term, perpetual), purchase, lease, lease with option to purchase, etc. How much will maintenance and new releases cost? All options must be spelled out in detail. The method of financing depends on a number of factors including useful life of system, potential salvage value, desire to use investment tax credit (ITC), etc. A safe set of assumptions is a two-three year life with little or no salvage value. The users would then frequently move up to other equipment with more power.

Price is not all. Here is a partial list of questions which must be answered for hardware, software or services.

- o Maintenance - who will fix it? When? What happens on weekends or after hours if the system fails?
- o Warranty - How long? What happens if the system is modified?
- o Updates/later releases - Are you assured of getting the latest releases of the system?
- o Schedule - What if schedules are not met? Who pays?
- o Support - How will the vendor support you during installation? How will the system be kept up to date?
- o Rejection - Do you have a trial period in which you can reject the system?
- o Multiple sites - Suppose you later wish to install the same system elsewhere, how much will it cost?
- o Viability/fallback - If the vendor goes bankrupt, what happens to you and your system?
- o Disputes - What procedures will be pursued to resolve problems?
- o Payment - Who gets paid? When? Under what conditions?
- o Training - Who will do the training? How much will be done?

- o Performance - How will the system performance be measured after installation?
- o Compatibility - What is the vendor's assurance that the vendor's product will remain compatible with the user's setting? What type of compatibility is needed?
- o Acceptance - Who is responsible for establishing these criteria, data collection, and evaluation? Under what conditions will the system be accepted?
- o Failure - How are the vendor performance and products likely to fail? What happens if they fail? Who decides when failure has occurred?
- o Contract type - What type of contract is most appropriate - a standard one from a vendor, a current contract in force, or a new contract?
- o Trade-offs/negotiable items - What is your negotiating room on each requirement? What trade-offs are you willing to make?

The above comments and questions are general. They apply to minicomputers themselves, software, and services. There are additional, more specific questions which need to be asked for hardware and software. These are:

- o Hardware

Hardware here includes computer equipment, system software, and support.

- What do you get?

The vendor must specify the hardware and system software by name, number, size, etc. The hardware configuration is needed along with the requirements of the software. System performance is needed. Specification of compatibility, interface, field modification terms are necessary. Manuals can be referenced and attached.

- What is the support?

What is the support for cabling, site preparation, physical installation, power support, air conditioning, water cooling, humidity and dust control, education, training materials, test time? What other resources will the manufacturer supply?

- What will it cost?

How long does the contract run? How much is paid? When? Under what conditions? Can funds be withheld pending evaluation of vendor performance? What are the taxes and transportation charges? Who gets the investment tax credit? Is credit issued if a failure occurs? What are charges for spare parts, supplies, overtime and holiday work, training and consulting? Is there protection against price increases?

- Will it work?

The system must be reliable and accepted by the user. Reliability means the estimated mean time to failure, mean time between failures, mean time to repair and availability of a certain percent over a given period. Provisions are necessary for part replacement, backup and disaster.

To ensure that these terms are met acceptance must be done. The acceptance testing period ensures operation, performance, compatibility, and reliability. Of particular interest here is stress testing where a system is subjected to a high number of active terminals.

- How will it be fixed?

Will it be fixed at the user site? When? How long after notification of failure? What support must be given to maintenance personnel? Who supplies spare parts? Can parts be reconditioned and resold? What reporting and logging procedures are needed for malfunctions? Under what conditions will preventive maintenance be done?

- When will you get it?

For computers delivery is critical. If you get all parts but one essential part, you may have a worthless system until that last

part is delivered. Terms must be set on early or late delivery, delays, and installation responsibility.

- What are your rights?

Can you add hardware to it? What about equipment of other manufacturers? Can you upgrade it or trade it in? Can you move it around? Can you buy it? Under what terms?

- o Software

Software here includes software packages as well as services. Such packages and services come as a part of acquiring systems from turnkey vendors.

- What do you get?

In addition to hardware the turnkey would deliver application software coded in a computer language along with documentation on operating and using it. The contract should specify the deliverable items as to content, number of copies, software updates and software enhancements. The contract should state the system software necessary to support the application and implementation support provided by the vendor at no additional cost.

- Does the software consume reasonable levels of resources? The contract should specify the number of terminals, type of use and performance that can be anticipated.
- When is payment made?

The payment schedule in the contract depends on whether the turnkey vendor is going to modify the software or develop new software. If there is to be development, payments should be based on the achievement of tangible events and milestones. Damage clauses are useful here to permit the contract to be voided.

For a software package a common financial approach is usually a one-time fee for a perpetual license. In addition, there is usually an annual maintenance fee which provided for updates and new releases. The contract should protect the user from any property tax if, in the future software is declared taxable.

- What legal protection regarding ownership is needed?

The vendor must state in the contract that he is the owner and has the right of sale. The user must agree to protect the software from willful violations of copyrights, patents, etc. "Save harmless" clauses are needed to protect users from accidental events.

6. Planning and Monitoring the Project

With the negotiation and signing of the contract project planning must be done to monitor vendor work and to ensure that user requirements are satisfied in the end products. This section assumes software and hardware work are done by a vendor. System development would follow internal guidelines. Elements of a project plan include:

- o Schedule - activities and milestones for each phase (design, development, etc.); persons assigned, equipment needed; budget
- o Organization control - a plan on who is working on the project and their interrelationships
- o Documentation - content outline, user, brief description of all documents, number of copies, how documents will be maintained
- o Training - the plan for who is to be trained in what means during what timeframe
- o Review and reporting - the method for reviewing and reporting on all project work
- o Change control - the approach to reviewing and approving changes

- o Testing - the plan to test each part of the system as well as the system and subsystems
- o Data conversion - the type, characteristics, volume and responsibility for converting data to the new system
- o Acceptance test plan - the method by which the delivered system will be tested as to function and performance and accepted
- o Installation - the plan for installing and turning over the minicomputer system to maintenance

The extent of the plan and the activities depend on the scope and nature of the application. Obviously a small turnkey minicomputer system with no modifications requires substantially less detail than a multiple minicomputer network with customized software. In most cases some tailoring of the software is needed.

In planning care must be taken on delivery of the hardware. In general it should not be delivered until software is ready to run. Otherwise, it sits there doing nothing and can become a political liability. Also, the user is essentially paying something for no usable function. If part of the software can be used, then it can be considered. Not taking the hardware removes pressure from accepting deficient software just to have an operational system. In general it is advisable to take these possibilities into account in a contract section on acceptance.

During system development, users must commit substantial resources to assist in the design and review vendor work. The resources include the right people and information. It could involve part of one person's time, up to several people full time. Failure to assign appropriate staff may result in project delays and misunderstandings between vendor and user staffs.

The role of project management needs to be emphasized here. With multiple vendors, someone from the user or system organizations must coordinate and manage the project activities. The duties of a project manager include:

- Arranging for scheduled and periodic review and project meetings.
- Coordinating vendor's activities to ensure compatibility and maintain the integrity of the schedule.
- Monitoring vendor activities, budgets and handling disputes.

Depending on the scope of effort, the project manager may have to be assigned full time. The amount of time depends on modifications to software, schedule, overall cost, and importance of the project.

What happens if things start to go wrong? How can this be detected early? Here are some signs that problems may arise:

- Project staffing by the vendor changes frequently possibly indicating staff dissatisfaction, low priority of work, etc.

- Milestone slippage or only partially satisfied milestones.
- Communication problems between users and vendor staff.

How can problems be uncovered early? By regular frequent meetings with the vendor technical representative. One way to ensure this is to appoint an implementation review group that meets weekly or bi-weekly and reviews progress, answers questions, and resolves problems. The use of measurable milestones of design documents, data dictionaries, program specifications and listings, test results, etc. should be emphasized. An updated action slate of items needed to be resolved should be established. Doing this absorbs more management time and it may not prevent all problems. However, problems will be surfaced earlier and given proper attention. The review group can also resolve requests for changes to the originally agreed upon requirements.

As the date for installation of the system approaches, concern and questions arise. After all this work will the system function? One way to minimize this is to involve users in training and operation with parts of the system that are completed. This can be done on the vendor premises. This effort cannot be too extensive since it may detract from the completion of the system.

7. Installation and Maintenance

In this section the following questions are addressed:

- o How should the site for the minicomputer be prepared? What steps are involved?
- o What is the managerial and administrative structure necessary?
- o How is the system accepted by users?
- o What are on-going requirements? What controls and reviews are needed?

These will now be examined in the following subsections.

- o Site preparation

Physically the minicomputer must be placed in a proper location. There are several factors to consider in location and site preparation.

- Terminals must be within a specific number of feet of the computer. Distance is measured in cable feet not shortest distance. The range is specified by the manufacturer. The range places a limitation on which floors of a building are feasible. Growth should be considered since the cable limit is likely to remain for some time.

- Considerable planning and effort is needed in laying out cable paths and specifying how much cabling is to be done. If a building does not have utility "tunnels", then there may be considerable expense in going through walls, ceilings, etc. Because of the setup cost and initial cost it is usually recommended to cable locations allowing for at least two years growth.
- In planning the computer facility consideration needs to be given to forms/paper storage, output distribution, work areas to perform maintenance on equipment, and staff space. The area selected may need to be convenient to a shipping/loading dock or convenient for user access.
- Although most minicomputers do not require heavy air conditioning or power, provision needs to be made for times (e.g., weekends, holidays) when building air conditioning is shut down or when it is reduced to conserve energy. Allowance for backup air conditioning and power may be necessary.
- In addition to the site being prepared, there may be a need for a backup site for data storage in another building. This is usually a secure room where backup file copies and program listings are retained for recovery if needed.
- Consideration needs to be given to security. Equipment needs to be protected from fire, smoke, water, or other damage. The degree of protection depends on the particular user situation. Often it is

sufficient to use the building's protective systems. Related to this is physical security to protect the system from damage by people. Access limitations are commonly used. Making it more difficult to be around the machine will reduce the likelihood of damage through inadvertent or intentional acts.

o Administrative Support

A minicomputer requires an administrative framework which is as comprehensive, but more limited than that for a large mainframe. In operations the following areas must be addressed:

- Staff support - number of shifts during which the machine is operated; support needed on each shift.
- Backup procedures - timing and frequency of system backup, checkpoint/recovery/restart procedures.
- Operations documentation - procedures to document an application system to support its day to day operation. This includes data input, job production, report distribution, recovery, and system startup.
- Security and password procedures - methods for assigning/deleting passwords.
- Accounting/auditing - procedures for auditing transactions, performing billing and job accounting, naming conventions for files, programs, etc.

- Report distribution and data control - control procedures for report distribution and information archival.
- Allowance for growth - procedures for handling increased numbers of users and applications.
- Performance monitoring and system review - procedures to check the utility and performance of hardware, system software, communications and application software.

Of course the amount of attention given to these areas depends on the applications being processed. However, it should be emphasized that in even simple stand alone computer equipment, problems may occur because of lack of operational procedures and lack of delegation of responsibility to a "systems manager" type person. When this happens users rapidly lose confidence in the system and revert to their own manual procedures.

The above discussion highlights a common myth which is not discounted by minicomputer vendors - that minicomputers usually need little, if any, support. It is not difficult to see why this view persists - since adding operational costs to the other system costs reduces the attractiveness of the minicomputer alternative.

o Acceptance testing

After delivery of the system and user training, the user organization assisted by systems support carries out acceptance testing according to the

project plan. This should address who defines, prepares, executes, and evaluates test cases as well as test criteria. In acceptance testing the following basic questions are answered:

- Is the system capable of performing the functions identified in the user requirements? This pertains to all parts of input, processing, reporting, inquiry, and report generation capability.
- Does the system satisfy the requirements on performance? Performance here often means response time and volume of information handled with the system under stress. Stress can be generated with a large number simultaneous active terminals, a large transaction volume, or by a heavy job load.

After acceptance testing there is either acceptance of the system or additional development work by the vendor.

o Maintenance and Enhancement

As the application software is used in production, new needs arise. Initially, after a system begins to function in production, most effort goes into fixing problems in the system that were not detected during development. After this period most demands for system changes are for enhancements - adding new features to the system. These enhancements include:

- Adding/modifying reports

- Adding data elements to files/reports
- Adding inquiry capability at terminals

If these activities are not monitored and controlled, the time and expense can rapidly escalate. A minimal level of controls are suggested to ensure cost control and system integrity. This includes:

- Log of all requests for changes to a system along with a cost-justification for the changes
- Recording and maintaining copies of the latest version of files/documents/source code
- Retest procedures to ensure new versions of systems are functional before replacing the older version
- Documentation update procedure to keep user and operations documentation current

In addition a periodic audit of each operational system is recommended to ensure that the system is being used and operated periodically.

Appendix A: Minicomputers and the Minicomputer Industry

Traditionally, minicomputers were defined as general purpose machines whose cost did not exceed \$100,000. Today, this definition is shifting as the price-performance ratio of machines improves. There are over 100 minicomputer hardware vendors in the marketplace. Many of these obtain basic parts from other manufacturers and then package and market the systems to end users. The leading vendors and the percentage of market share are shown in Figure 7. Figure 4 shows the rising number of minicomputer installations by market category. As can be seen, this is a market which is very competitive and in which IBM holds a sizeable, but not as yet dominant, market share. There appears to be an increased likelihood of a shakeout of vendors as the market matures, as the chip manufacturers compete (e.g., Texas Instruments), and if IBM increases its competitive aggressiveness.

Historically, minicomputers offered fewer capabilities than mainframes. This is no longer the case. Price performance improvements and competitive pressure have seen the emergence of a variety of minis which support mainframe functions, such as:

- o Language - COBOL, FORTRAN, BASIC, APL, PASCAL
- o Operating Systems - Multi-tasking, virtual systems
- o Memory - up to 1-2 million bytes of main memory
- o Peripherals - wide variety of printers, disks, tapes, diskettes

It should be noted that the most common language is BASIC. Versions of COBOL are often subsets of those available on mainframes.

In general, minicomputers can operate in standard office environments; some can operate in harsh environments with respect to temperature, humidity, and dust. There are no special air conditioning or water cooling requirements. Most minis require only standard power supplies.

Minicomputers here are usually computers which can be operated in customer environments.

Many minicomputers would have been classified as mainframes as little as five years ago based on their processing power and capabilities. Mainframe manufacturers have announced and introduced low end mainframes which are priced as minis (e.g., IBM-4331). In short, the line between mainframe and minicomputer has become blurred leading to some confusion and uncertainty among potential users.

Compounding the variety and extent of products and vendors is the emergence of a service/software industry tied to the minicomputers. To encourage sales of hardware, minicomputer manufacturers have stimulated development of application software by giving software companies discounts on hardware. This provides an added profit margin to the software company and solidifies the relationship between the two organizations. Two terms used frequently are OEM and turnkey company. OEM (Original Equipment Manufacturer) is a company which obtains hardware at a discount and packages it; a turnkey company is a company which offers a total solution of hardware, application software, and consulting. Until the recent

announcement by IBM making the Series/1 available for OEM discounts, IBM ignored this marketing approach. The effect of this position has been to somewhat retard the development of application software for IBM minis. Sales of IBM minis may be harder to make because of the cost of customized software.

**FIGURE 4: Vendors and Market Share for 1978 -
General Purpose Minicomputers***

Digital Equipment (e.g., PDP11, VAX)	- 39.7%
Data General (e.g., NOVA, ECLIPSE)	- 20.3%
Hewlett-Packard (e.g., HP 1000, 3000)	- 9.3%
Mod comp	- 5.1%
IBM (e.g., Series 1, System 32)	- 3.7%
Perkin Elmer	- 3.7%
Honeywell	- 2.9%
Computer Automation	- 1.9%
Sperry Univac	- 1.8%
Microdata	- 1.6%
General Automation	- 1.4%

*Source is Dataquest

FIGURE 5: Minicomputer Installations by Market Category - 1978*

Vendor	Manufacturing	Service Indust.	Educ., Research Government	Other
Digit Equip	31%	20%	43%	6%
Data Genl.	42	18	37	3
Hewlett-Pack	35	19	40	6
Modcomp	13	10	70	7
IBM	29	51	10	10
Perkin Elmer	30	28	36	6
Honeywell	19	44	34	3

*Source - Dataquest

What is the target audience for minicomputer hardware/software/service vendors?

Raw hardware is not intriguing to many end users unless they have substantial internal systems capability. The time to build the software and the cost of construction also reduce the attractiveness of this path.

The more common approach is to propose a total solution - the turnkey approach. A package is attractive - it works now or soon; it is tested; costs are better defined. These features appeal to many users. A turnkey system also can give users potentially more control over their computing environment. This can be a mixed blessing. There may be substantial operational and managerial costs and risks with a turnkey approach.

How is marketing performed? Often there is casual contact at trade shows or meetings between vendors and potential users. Vendors often pursue these contacts with vigor. In some organizations turnkey vendors represent a threat to systems groups. They may take away business. The system group may be forced to absorb substantial maintenance and enhancement costs after a turnkey installs a system. In previous times the high cost of such systems created a high level of visibility and attention. This is no longer usually true. Systems groups today have more work than can be handled with their resources. In many situations more responsibility is borne by the end user. This creates a need for a minimum level of expertise in user organizations.

Applications on minicomputers can be classified in several ways including:

- o Single application - The mini is dedicated to a single purpose. Examples are controlled areas in buildings and garages, point of sale systems, in supermarkets, banks, etc., engineering and instrumentation applications (e.g., process control).
- o General purpose computing - The mini functions as a computer to provide general timesharing supports. Users write their own programs. There are no software production applications.
- o Multiple defined applications - The mini supports a fixed number of applications. Users do not write their own software. An example is a minicomputer dedicated to accounting functions - general ledger, accounts payable, accounts receivable, payroll, etc.
- o Mixed computing - The mini functions include both general purpose computing and a defined set of applications operating in a production mode.

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